(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 472 536 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **14.12.94** (51) Int. Cl.5: **B65B 69/00**, B65G 65/00

(21) Application number: **90906628.4**

(22) Date of filing: **13.04.90**

(86) International application number:
PCT/US90/01995

(87) International publication number:
WO 90/14273 (29.11.90 90/27)

(54) SEALABLE TRANSPORTABLE CONTAINER HAVING IMPROVED LATCH MECHANISM.

(30) Priority: **19.05.89 US 354027**

(43) Date of publication of application:
04.03.92 Bulletin 92/10

(45) Publication of the grant of the patent:
14.12.94 Bulletin 94/50

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB IT LI LU NL SE

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application is related to the following Applications/Patents, all assigned to the assignee of the subject Application, in that they all have particular relevance to SMIF systems.

SEALED STANDARD INTERFACE APPARATUS, Inventors: George Allen Maney, Andrew William O'Sullivan, W. George Faraco, Serial No. 635,384, Filed: July 30, 1984, now U.S. Patent No. 4,674,939;

DOOR ACTIVATED RETAINER, Inventors: George Allen Maney, W. George Faraco, Mihir Parikh, Serial No. 686,443, Filed: December 24, 1984, now U.S. Patent No. 4,815,912;

LONG ARM MANIPULATOR FOR STANDARD MECHANICAL INTERFACE APPARATUS, Inventors: Anthony Charles Bonora, Andrew William O'Sullivan, Serial No. 769,709, Filed: August 26, 1985, now U.S. Patent No. 4,676,709;

SHORT ARM MANIPULATOR FOR STANDARD MECHANICAL INTERFACE APPARATUS, Inventors: Anthony Charles Bonora, Serial No. 769,850, Filed: August 26, 1985, now U.S. Patent No. 4,674,936;

CONTAINER HAVING DISPOSABLE LINERS, Inventors: Mihir Parikh, Anthony Charles Bonora, W. George Faraco, Barney H. Huang, Serial No. 829,447, Filed: February 13, 1936, now U.S. Patent No. 4,739,882; and

SEALABLE TRANSPORTABLE CONTAINER HAVING A PARTICLE FILTERING SYSTEM, Inventors: Mihir Parikh, Anthony C. Bonora, Serial No. 840,380, Filed: May 1, 1986, now U.S. Patent No. 4,724,874.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to standardized mechanical interface (SMIF) systems for reducing particle contamination, and more particularly to transportable containers which are sealable to prevent influence of external factors on the contents of the containers.

Description of the Related Art

A standardized mechanical interface (SMIF) system has been proposed by the Hewlett-Packard Company as disclosed in U.S. Patent No. 4,532,970 and 4,534,389. The purpose of the SMIF system is to reduce particle fluxes onto wafers. This end is accomplished, in part, by mechanically ensuring that during transportation and storage the gaseous media (such as air or nitrogen) surrounding the wafers is essentially stationary relative to the wafers and by ensuring that particles from the ambient environment do not enter the immediate wafer environment. The SMIF concept is based on the realization that a small volume of controlled (with respect to motion, air flow direction and external contaminants), particle-free air provides a clean environment for wafers. Further details of one proposed system are described in the article entitled "SMIF: A TECHNOLOGY FOR WAFER CASSETTE TRANSFER IN VLSI MANUFACTURING," by Mihir Parikh and Ulrich Kaempf, Solid State Technology, July 1984, pp. 111-115.

Systems of the above type are concerned with particle sizes which range from below 0.1 micrometers to above 200 micrometers. Particles with these sizes can be very damaging in semiconductor processing because of the small geometries employed in fabricating semiconductor devices. Typical advanced semiconductor processes today employ geometries which are 1 micrometer and under. Unwanted contamination particles which have geometries measuring greater than 0.05 micrometers substantially interfere with 1 micrometer geometry semiconductor devices. The trend, of course, is to have smaller and smaller semiconductor processing geometries which today in research and development labs approach 0.5 micrometers and below. In the future, geometries will become smaller and smaller and hence smaller and smaller contamination particles become of interest.

A SMIF system has three main components: (1) minimum volume, sealed pods used for storing and transporting wafer cassettes; (2) canopies placed over cassette ports and wafer processing areas of processing equipment so that the environments inside the pods and canopies (after having clean air sources) become miniature clean spaces; and (3) a transfer mechanism to load/unload wafer cassettes from a sealed pod without contamination of the wafers in the wafer cassette from external environments.

Wafers are stored and transported in pods, and are transferred from a pod to a piece of processing equipment in the following manner. First, a pod is placed at the interface port on top of the canopy. Each pod includes a box and a box door designed to mate with doors on the interface ports of the processing equipment canopies. Then, latches release the box door and the canopy port door simultaneously; the box door and the interface port door are opened simultaneously so that particles which may have been on the external door surfaces are trapped ("sandwiched") between the box and interface port doors. A mechanical elevator lowers the two doors, with the cassette riding on

top, into the canopy covered space. A manipulator picks up the cassette and places it onto the cassette port/elevator of the equipment. After processing, the reverse operation takes place.

The SMIF system has been proved effective by experiments using prototype SMIF components both inside and outside a clean room. The SMIF system provides at least a ten-fold improvement over the conventional handling of open cassettes inside the clean room.

Conventional SMIF pods have the potential to create particles due to physical scraping of latch mechanisms against latch surfaces. Although few particles are released during each latching operation, over the course of hundreds of processing steps for a wafer, the number of particles created each time the SMIF pod is latched and/or unlatched may build to a significant number.

In SMIF pods utilizing conventional latching systems, scraping occurs when a latch member and a latch surface, one or both of which have a sloped surface, move from a disengaged to a fully engaged orientation. The sealing surfaces on the box and the box door are designed to seal upon application of pressure which forces these sealing surfaces together, and thus the latch system must (a) prevent movement of the box door with respect to the box and (b) create a clamping force which forces the sealing surfaces together. The clamping force is generated by sliding the latch surface along a sloped latch member or vice versa.

Latch mechanisms on conventional SMIF pods are usually provided on the box so that the latch mechanism may alternately be used to clamp the box door to the box or to clamp the box to the port plate of a processing station. To provide this dual function, it is necessary to have notches or openings in the perimeter of the bottom of the box so that the latch mechanisms could move to engage either the box door or the port plate. These openings provide access points through which contaminants may enter the "clean" environment.

In conventional SMIF pods, the latch mechanism supports the edges of the box door creating the possibility that the box door will deflect (bow or bend) under the weight of the wafers resting on the box door in addition to the sealing forces, potentially creating leaks in the seal between the box and the box door. Further, conventional latch mechanisms for SMIF pods may be subject to tampering which allows unauthorized access to the contents of the container.

US-A-4,132,327 discloses a hatch cover opening and closing assembly. Locking arms provided under the hatch may be rotated, by way of a handle provided above the hatch, to align with locking lugs. A separate movement of the handle then lifts the arms into engagement with the lugs thereby locking the hatch.

SUMMARY OF THE INVENTION

The present invention provides a sealable, transportable container, comprising:

a box having an interior region and a first sealing surface;

a box having a second sealing surface adapted to mate with said first sealing surface when said box door is moved in a sealing direction; and

first and second latch members each adapted for motion in a first direction between a first position, which allows motion of said box door with respect to said box, and a second position, which limits the motion of said box door with respect to said box, without scraping contact between said latch members and said box or said box door in said interior region, and motion in a second direction between said second position and a third position, without scraping contact between said latch members and said box or said box door in said interior region, to move said box door in the sealing direction and to bring said first and second sealing surfaces into contact.

The present invention also provides a SMIF pod comprising a sealable transportable container as described above, in which:

said box has at least two latch engaging surfaces, said first and second sealing surfaces provide a seal which isolates said interior region from ambient pressure conditions when said box door is moved in a sealing direction with respect to said box; and

said first and second latch members are provided in said box door, each latch member having at least two box engagement portions and being movable between said first position which is a disengaged position, said second position which is an engaging position and said third position which is an engaged position, and said latch members are adapted to move from the disengaged position to the engaging position without contacting said box and whereby movement of said latch members from the engaging position to the engaged position causes said at least two box engagement portions of said latch members to contact respective ones of said at least two latch engaging surfaces without scraping said latch members against said at least two latch engaging surfaces and to move said box door in the sealing direction; and further comprising;

two-stage cam means centrally located in said box door for moving said latch members from the disengaged position to the engaging position in a first independent stage of operation and for moving said latch members from the engaging position to the engaged position in a second independent

stage of operation.

This invention further provides a SMIF system for maintaining the cleanliness of articles to be processed, comprising a SMIF pod as described above, the interior region being adapted for containing the articles, the box having a further sealing surface;

a port plate having first and second port plate sealing surfaces, said first port plate sealing surface sealably mating with the further box sealing surface; and

a port door having a first port door sealing surface for sealably mating with the second port plate sealing surface for making a seal, the port door including means for operating said two-stage cam means.

The present invention thus advantageously provides a sealable, transportable container having a latch mechanism which operates without any scraping or rubbing contact of the latch mechanism and portions of the container container contacted by the latch mechanism.

A further advantage of the preferred embodiment of the present invention is the provision of a latch mechanism which supports the box door at positions which minimize deflection (or bowing) of the box door.

Another advantage is the provision of a transportable container in which the latch mechanism is tamper resistant to prevent unauthorized access to the contents of the container.

Another advantage is the provision of a SMIF pod having a latch mechanism which is centrally operated.

These and other objects and advantages of the invention will appear more clearly from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is an isometric view of a processing station having a canopy for receiving a SMIF pod;

Fig. 1B is a cutaway side view of the processing station of Fig. 1;

Fig. 2A is an isometric view of a SMIF pod and portions of a port assembly for receiving the SMIF pod;

Fig. 2B is a sectional view along line B-B of Fig. 2A;

Fig. 3 is an isometric, exploded view of a SMIF pod in accordance with the present invention;

Figs. 4 and 5 are plan views of a latch mechanism in accordance with the present invention in first and second positions, respectively;

Figs. 6 and 7 are plan views of a two-stage rotary cam of the latch mechanism in first and second positions, respectively;

Fig. 8A is a plan view of an interface portion of a SMIF pod box which interacts with the latch mechanism of the present invention;

Fig. 8B is a sectional view along line 8B-8B in Fig. 8A;

Fig. 8C is a sectional view along line 8C-8C in Fig. 8A;

Fig. 9 is a partial cutaway side view of the interface portion shown in Fig. 8;

Figs. 10 and 11 are side views showing the latch mechanism of the present invention in the second position and a third position, respectively;

Fig. 12 is a plan view of the two-stage rotary cam;

Fig. 13 is a side view of the two-stage rotary cam;

Figs. 14 A and B are schematic, isometric views of box doors showing different deflection patterns; and

Figs. 15A and B are side, isometric views of box doors showing different deflection patterns.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in the context of a SMIF system for storing and transporting wafers and/or reticles. However, it is to be understood that a sealable, transportable container in accordance with the present invention may be used to store and transport many other inanimate objects as well as living objects such as laboratory animals.

The general structure of a SMIF pod and the mating of a SMIF pod with processing equipment are described in U.S. Patent No. 4,724,874 which is hereby incorporated by reference. However, for completeness, a brief description of the disclosure is provided herein.

Figs. 1 and 2 illustrate a processing station 8 having a canopy 10 which is an easily removable shield that covers the wafer handing mechanism of processing equipment 12. Equipment 12 may be, for example, a photo resist applicator, mask aligner, inspection station or any similar processing equipment. The canopy 10, which is constructed of transparent plastic such as acrylic or Lexan to facilitate visual inspection and/or maintenance within the canopy 10, encloses the handling mechanisms of the processing equipment 12 and a holder 14, such as a wafer cassette holding wafers 16. The environment within the processing equipment is separately maintained and separately cleaned and therefore the equipment 12 need not be installed in a clean room.

A sealable, transportable container (or pod) 18 having a box (or box top) 20 having an interior region 21 and a box door 32 is mounted on the horizontal surface 22 of canopy 10 by a port assembly 24. The port assembly 24 includes a port plate 26, port door 28, and an elevator mechanism 30. Elevator mechanism 30 transports a cassette holder 14, containing the integrated circuit wafers 16 from the interior region 21 of box 20 into the region beneath the canopy 10. In Fig. 1B, port door 28 and box door 32 are shown in the closed position by the dotted lines. A mover assembly 34 includes a platform 36, a shaft engagement device 38 and a drive motor 40. The platform 36, extending from the elevator assembly 30, carries the port door 28, the box door 32 and the holder 14 in a vertical direction. The platform 36 is attached by engagement device 38 to a vertical guide 42 of elevator assembly 30.

Typically, guide 42 includes a lead screw (not shown) and the drive motor 40 drives a gear (not shown) which engages the lead screw for driving the platform 36 up or down. When the platform 36 is driven to the closed position, the port door 28 closes the port opening in the canopy 10.

In a similar manner, a manipulator assembly shown generally by the numeral 44 is fastened to a platform 46 which has an engagement means 48 for engaging the vertical guide 42. Manipulator assembly 44 includes a manipulator arm 50 and an engagement head 52 adapted to engage holder 14. By vertical operation of the platforms 36 and 46 and by operation of the manipulator assembly 44, the holder 14 is moved from its position on the box door 32 to a position on the equipment station 13 (as shown by the broken lines).

Fig. 2A is an exploded view of container 18 and port assembly 24. Container 18 can be alternately pressurized or evacuated when box 21 and box door 32 are sealed together to isolate the interior region of box 21 from ambient conditions. Port plate 26 is connectable to a coaxial injector/extractor 50 at gas transfer valve 52 (Fig. 2B).

Fig. 2B shows container 18 mated to port assembly 24 of processing equipment 12. Container 18 is designed for sealably mating with the port assembly 24, and thus box 20 has first and second box top sealing surfaces 54, 56, respectively. Box door 32 has a first box door sealing surface 58 for sealably mating with the first box top sealing surface 54, and gasket 55 between surfaces 54 and 58 provides a seal. Port plate 26 has first and second port plate sealing surfaces 60, 62, respectively. The first port plate sealing surface 60 sealably mates with the second box top sealing surface 56, making a second seal as gasket 57 is compressed.

Port door 28 has a first port door sealing surface 64 which sealably mates with the second port plate sealing surface 62; a third seal is provided by gasket 59. The box top 20 may include a conduit 63 defining a channel between valve 52 and the interior space 21 of box 20. At one end of channel 66 is a filter 69 for filtering fluids (e.g., gasses) passing therethrough.

When the first, second and third seals are made, the interior space 21 of box 20 may cleaned by alternately evacuating/pressurizing the interior space 21. In order to evacuate interior space 21, injection/extractor 50 is activated to withdraw fluid from interior space 21. As the fluids are withdrawn, they pass through filter 69, through channel 66 and through a coaxial valve (not shown) of injection/extractor 50.

The port door 28 includes a latch actuating mechanism 66 having pins 70 for actuating the box door latch mechanism 80 and thereby releasing box door 32 from box 20. Wafers 16 can be moved by elevator mechanism 30 and mover assembly 34 into the proper position in the processing equipment 12 for processing without human intervention.

A latch mechanism for a SMIF pod in accordance with the present invention will be described with reference to Figs. 3-13. In the preferred embodiment, the latch mechanism is provided in box door 32 and centrally actuated, allowing a single latch actuating mechanism to release the box door 32 from the box 20. Alternatively, a latch mechanism in accordance with the present invention could be provided in box 20.

With reference to Fig. 3, box 20 includes a domed housing 90 and a ring-like engaging portion 92. Housing 90 and engaging portion 92 may be formed integrally, for example, by injection molding, or as separate components assembled to form box 20. A gasket 120, which provides the seal between box 20 and box door 32 resides in a gasket-retaining slot 122 in box door 32. In the preferred embodiment, a liner (not shown) is provided on door 32 and gasket 120 contacts the liner. The liner is a removable element which may be formed of, for example, plastic materials which do not outgas or introduce particles, as described in U.S. Patent No. 4,739,882, which is hereby incorporated by reference. The liner may also be formed of a material which provides the capability of dissipating or preventing the formation of static charges. Latch mechanism 80 is housed in base 32 and latch mechanism 80 protrudes from box door 32 through windows 94 to engage latch engaging surfaces 112_{1-8} (Figs. 8-9) of box 20.

The two-stage rotary cam latch mechanism 80 of the present invention includes first and second latch plates 101_{1-2}, a cam mechanism 103 pivotally mounted on box door 32, and latch plate

supports 105_{1-6}. The operation of latch mechanism 80 is a two-stage operation which is illustrated in Figs. 4-7 and 10-11. In the first stage of operation, cam mechanism 103 slides latch plates 101_{1-2} linearly, and in the second stage, cam mechanism 103 causes latch plates 101_{1-2} to pivot on latch plate supports 105_{1-6}.

Each latch plate 101_{1-2} has at least one box-engaging portion; in the preferred embodiment of the present invention, designed for use in a pod for storing and transporting 200mm wafers, each latch plate 101_{1-2} has two latch arms 108_{1-2} and 108_{3-4}, respectively. Latch arms 108_{1-4} each have two latch fingers 110_{1-8} which engage respective ones of latch engaging surfaces 112_{1-8} of box 20.

The first stage of the latching operation involves moving latch plates 101_{1-2} from retracted (or disengaged) positions (Fig. 4) where the latch plates 101_{1-2} are entirely contained within box door 32 to extended (or engaging) positions (Fig. 5) where latch fingers 110_{1-8} extend out of box door 32 and are adjacent to latch engaging surfaces 112_{1-8} of box 20. In the first stage when the latch plates 101_{1-2} move from the retracted position to the extended position in a plane parallel to the plane of box door 32, latch fingers 110_{1-8} do not contact latch engaging surfaces 112_{1-8}. Accordingly, there are no particles created by scraping or rubbing of the latch fingers 110_{1-8} against the latch engaging surfaces 112_{1-8}.

The second stage of the latching operation involves substantially vertical motion of latch fingers 110_{1-8}. "Vertical motion" refers to motion in a direction perpendicular to the plane of box door 32, and to the plane of motion of latch plates 101_{1-2} during the first stage of the latching operation. The motion of latch fingers 110_{1-8} during the second stage engages latch fingers 110_{1-8} with respective ones of latch engaging surfaces 112_{1-8}, and creates a latching and/or clamping force which sealably mates a first sealing surface of box 20 with second sealing surface of box door 32. The first sealing surface comprises knife edge 118 on box 20, and the second sealing surface comprises gasket-retaining slot 122 in box door 32. A gasket 120 sits in gasket-retaining slot 122 and forms the seal between box 20 and box door 32. Gasket 120 is preferably fabricated from a resilient, compressible material which does not release particles when contacted and compressed by knife edge 118 or outgas. Fig. 8A illustrates engaging portion 92 of box 20 in a plan view and Figs. 8B and 8C illustrate knife edge 118 in cross section. As discussed above, a liner may be provided between box door 32 and gasket 120.

Latch mechanism 80 resides in a cavity 124 in box door 32. Accordingly, any particles generated by the interaction of cam mechanism 103 and latch plates 101_{1-2} and/or latch plates 101_{1-2} and latch plate supports 105_{1-6} are contained in cavity 124. Additionally, it is possible to add a port in box door 32 so that cavity 124 may be evacuated in order to remove any particles which are created in cavity 124.

The details of the construction and operation of cam mechanism 103 will be described with reference to Figs. 6, 7, 10, 11, 12 and 13. Cam mechanism 103 is a two-stage cam mounted on a pivot post 130 (Figs. 10-11); pivot post 130 is attached to the top surface 32a of box door 32. First and second holes 132_{1-2} in cam mechanism 103 engage pins 70 of latch actuating mechanism 66. First and second slots 134_{1-2} are provided in bottom wall 32b of box door 32 to enable pins 70 to engage cam holes 132_{1-2}.

The two stages of operation of cam mechanism 103 and latch plates 101_{1-2} occur as follows. In the first phase of the latching operation, cam lobes 136_{1-2} engage camming surfaces 138_{1-2} (Figs. 6-7), respectively of latch plates 101_{1-2}. As cam mechanism 103 rotates through an angle of approximately 40° from an unlatched to an intermediate position, cam lobes 136_{1-2} cause latch plates 101_{1-2} to move from the retracted to the extended position. In order to maintain latch plates 101_{1-2} in a plane parallel to the plane of box door 32 during the sliding operation of the first stage of the latching operation, latch plate springs 140_{1-2} (Figs 10-11) are attached to respective ones of latch plates 101_{1-2} and force the cam arms 109_{1-2} of respective ones of latch plates 101_{1-2} towards cam mechanism 103. The biasing force provided by springs 140_{1-2} causes rollers 142_{1-2} of respective ones of latch plates 101_{1-2} to contact roller surface 144 of cam mechanism 103.

Risers 146_{1-2} (Figs. 10-13) are provided on roller surface 144 of cam mechanism 103. As cam mechanism 103 rotates beyond the first 40° of motion from the intermediate position to a latched position, linear motion of latch plates 101_{1-2} ceases and rollers 142_{1-2} begin riding up respective ones of risers 146_{1-2}. As rollers 142_{1-2} ride up risers 146_{1-2}, latch plates 101_{1-2} pivot about an axis defined by the contact points of latch plate 101_1 and a first group of latch plate supports 105_{1-3} and of latch plate 101_2 and a second group of latch plate supports 105_{4-6}. The pivoting motion of latch plates 101_{1-2} causes latch fingers 110_{1-8} to move substantially vertically without scraping motion of latch fingers 110 and latch surfaces 112. For the latch mechanism of the present invention, where latch plate supports 105_{1-6} are approximately 67mm (2-1/4") from fingers 110 when the latch plates 101_{1-2} are in the intermediate position and move vertically approximately 13.7mm (0.054") from the intermediate to the latched position, ex-

perimental results have shown that latch fingers 110 undergo horizontal motion of only approximately 0.03mm (0.001"). This minimal amount of horizontal motion prevents generation of particles by scraping.

In the unlatching operation rollers 142_{1-2} ride back down risers 146_{1-2} as cam mechanism 103 is rotated in the opposite direction. Springs 140_{1-2} provide the biasing force to keep rollers 140_{1-2} in contact with risers 146_{1-2}. After rollers 140 come in contact with roller surface 144, cam lobes 136_{1-2} engage cam surfaces 138_{1-2} of latch plates 101_{1-2} and move latch plates 101_{1-2} from the extended to the retracted position.

When latch plates 101_{1-2} and cam mechanism 103 are in the latched position, cam lobes 136_{1-2} are aligned with the axis of rotation of cam mechanism 103. Accordingly, any force tending to move the latch plates 101_{1-2} from the extended to the retracted position is transmitted along cam lobes 136_{1-2} through the rotational axis of cam mechanism 103 without creating any torque which would rotate cam mechanism 103 from the latched position. Thus, cam lobes 136_{1-2} physically maintain latch plates 101 in the extended position both during the second stage of the latching operation and when the latch mechanism is in the latched orientation, preventing the latch from releasing under the application of linear impacts.

The second stage of the latching operation provides a strong clamping force to engage knife edge 118 with gasket 120 in order to effect a seal which prevents external conditions from affecting the interior region 21 of pod 18. For example, this seal prevents particulate matter and moisture from entering interior region 21. Further, this seal allows the interior region 21 to be evacuated and backfilled with an insert gas. The clamping force is approximately 0.18N/mm (one (1) pound per linear inch). This clamping force is regulated by a slight bowing or spring action of latch plates 101_{1-2}. This bowing is designed into latch plates 101_{1-2} which are formed of 3.18mm (0.125-inch) thick aluminum alloy, for example, 7075-T6.

In order to prevent localized bending or deflection of the box door 32, due to the application of the clamping force, the clamping loads are distributed. One aspect to the distribution of the clamping force is the use of multiple latch arms 108_{1-4} for each latch plate 101_{1-2}. Latch arms 108_{1-4} are positioned at points which are half the distance from the center to the end of the edge of the box door. As shown in Fig. 5, for a box door having a width W, latch arms are a distance approximately W/2 from each other and a distance approximately W/4 from the edge of the box door.

To strengthen the latch engaging areas of the box 20, which is usually formed of plastic, a post is provided between each pair of latch engaging surfaces 112_{1-8} To accommodate this post each latch arm 1081-4 has latch fingers 110_{1-8} separated by a notch. The post serves to decrease the unsupported length of the latch engaging surfaces 112_{1-8} by a factor of approximately one third and to increase the shear area by a factor of 2.

Figs. 14A and 15A diagrammatically illustrate the deflection D_A of a box door supported only at its edges, i.e., at support points 200_{1-4} and having a load (FW_{1-n}) created by the wafers stored in the pod uniformly distributed over the area of the box door. In addition, a sealing force FS is applied at the periphery of the box door. Any section of the box door along length L can be treated as a beam and the maximum deflection D_A at the center varies with L^3. The deflections and stresses in loaded beams are known phenomena discussed in, for example, MACHINERY'S HANDBOOK, Obery and Jones, Industrial Press, 1963. If the amount of deflection D_A is too large, the seal between the box door and the box may be broken.

Figs. 14B and 15B diagrammatically illustrate that the maximum deflection D_B of a box door in accordance with the present invention is greatly reduced with respect to the deflection D_A of a box door supported only at its edges. In the box door of the present invention, the load of the wafers (FW) and the sealing force (FS) on the box door is supported at the positions of latch plate supports 105_{1-6}. Latch plate supports 105_{1-6} are located a distance A from the edge (or periphery) of the box door. Treating each section of the box door along length L as a beam, the maximum deflection D_B at the center varies with B^2 $(B^2-A^2)/L$. The application of the sealing forces FS to a cantilevered portion of the box door counters the deflection of the box door caused by the weight of the wafers. It has been determined that D_B for the box door of the present invention is approximately one tenth (1/10) of D_A. The distribution of latch plate supports 105 along the width of box door 32 prevents deflections along the width.

The latch mechanism 80 of the present invention does not require any interruptions of the perimeter of the base of box 20, thereby removing areas of access to the "clean" environment within box 20. Further, the entire latch mechanism is contained in box door 32 which facilitates cleaning of box 20. Tampering with latch mechanism 80 is virtually eliminated, due to the fact that forces intended to move the latch plates 101 from the extended to the retracted position do not rotate cam mechanism 103 and due to the fact that cam mechanism 103 is contained within cavity 124 of box door 32 so that unauthorized access would require rotating cam mechanism 103 by inserting an implement into cam holes 132. Accordingly,

access can be limited by the use of an interlock system which must be activated and/or mechanical keys which must be inserted before rotation of cam mechanism 103 is possible.

The many features and advantages of the present invention will be apparent to those skilled in the art from the Description of the Preferred Embodiments and the Drawings. Accordingly, the following claims are intended to cover all modifications and equivalents falling within the scope of the invention.

Claims

1. A sealable, transportable container (18), comprising:

   a box (20) having an interior region (21) and a first sealing surface (54);

   a box door (32) having a second sealing surface (58) adapted to mate with said first sealing surface when said box door is moved in a sealing direction; and

   first and second latch members (101_{1-2}) each adapted for motion in a first direction between a first position, which allows motion of said box door with respect to said box, and a second position, which limits the motion of said box door with respect to said box, without scraping contact between said latch members and said box or said box door in said interior region, and for motion in a second direction between said second position and a third position, without scraping contact between said latch members and said box or said box door in said interior region, to move said box door in the sealing direction and to bring said first and second sealing surfaces into contact.

2. A sealable, transportable container according to claim 1, wherein when said latch members are in said third position said box door is supported at positions (105) spaced from a peripheral edge of said box door to prevent said box door from deflecting.

3. A sealable, transportable container according to claim 1 or 2, further comprising an actuator (103) centrally positioned in said box door for moving both said first and second latch members from the first position to the second position and from the second position to the third position.

4. A sealable transportable container according to claim 3, wherein said actuator comprises a two-stage cam means.

5. A sealable, transportable container according to claim 1, 2, 3 or 4 wherein said first and second members are adapted for linear motion in the first direction and pivoting motion in said second direction.

6. A sealable transportable container according to any one of claims 1-5, wherein said latch members (101_{1-2}) are entirely contained within said box door when in said first position.

7. A standard mechanical interface (SMIF) pod, comprising a sealable transportable container according to claim 1, in which:

   said box has at least two latch engaging surfaces (112), said first and second sealing surfaces provide a seal which isolates said interior region from ambient pressure conditions when said box door is moved in a sealing direction with respect to said box; and

   said first and second latch members are provided in said box door, each latch member having at least two box engagement portions (108) and being movable between said first position which is a disengaged position, said second position which is an engaging position and said third position which is an engaged position, and said latch members are adapted to move from the disengaged position to the engaging position without contacting said box and whereby movement of said latch members from the engaging position to the engaged position causes said at least two box engagement portions of said latch members to contact respective ones of said at least two latch engaging surfaces without scraping said latch members against said at least two latch engaging surfaces and to move said box door in the sealing direction; and further comprising;

   two-stage cam means (103) centrally located in said box door for moving said latch members from the disengaged position to the engaging position in a first independent stage of operation and for moving said latch members from the engaging position to the engaged position in a second independent stage of operation.

8. A SMIF pod according to claim 7, wherein said latch members are entirely contained within said box door in said disengaged position.

9. A SMIF pod according to claim 7, wherein said first and second latch members are adapted for linear motion between the disengaged position and the engaging position and for pivoting motion between the engaging position and the engaged position.

10. A SMIF system for maintaining the cleanliness of articles to be processed, comprising:

a SMIF pod according to claim 7, the interior region being adapted for containing the articles, the box having a further sealing surface (56);

a port plate (26) having first and second port plate sealing surfaces (60; 62), said first port plate sealing surface (60) sealably mating with the further box sealing surface (56); and

a port door (28) having a first port door sealing surface (64) for sealably mating with the second port plate sealing surface (62) for making a seal, the port door including means for operating said two-stage cam means.

11. A SMIF system according to claim 10, further comprising:

conduit means (63) for communicating between the interior space and an environment external to the box; and

filter means (69) for filtering fluids passing through the conduit means.

Patentansprüche

1. Dichtbarer, transportabler Behälter (18), der aufweist:
einen Kasten (20), der einen Innenbereich (21) und eine erste Dichtfläche (54) besitzt;
eine Kastentür (32), die eine zweite Dichtfläche (58) besitzt, die dazu geeignet ist, zu der ersten Dichtfläche zu passen, wenn die Kastentür in eine Dichtrichtung bewegt wird; und
erste und zweite Verriegelungsteile (101_{1-2}), die jeweils für eine Bewegung in einer ersten Richtung zwischen einer ersten Position, die eine Bewegung der Kastentür hinsichtlich des Kastens ermöglicht, und einer zweiten Position, die die Bewegung der Kastentür hinsichtlich des Kastens begrenzt, und zwar ohne kratzenden Kontakt zwischen den Verriegelungsteilen und dem Kasten oder der Kastentür in dem Innenbereich, und einer Bewegung in einer zweiten Richtung zwischen der zweiten Position und einer dritten Position, ohne kratzenden Kontakt zwischen den Verriegelungsteilen und dem Kasten oder der Kastentür in dem Innenbereich, um die Kastentür in die Dichtrichtung zu bewegen und die ersten und zweiten Dichtflächen in Kontakt miteinander zu bringen.

2. Dichtbarer, transportabler Behälter gemäß Anspruch 1, wobei dann, wenn sich die Verriegelungsteile in der dritten Position befinden, die Kastentür an Stellungen (105) unterstützt werden, die von einer Umfangskante der Kastentür beabstandet sind, um zu verhindern, daß sich die Kastentür durchbiegt.

3. Dichtbarer, transportabler Behälter gemäß Anspruch 1 oder 2, der weiterhin ein Betätigungsglied (103) aufweist, das zentral in der Kastentür zur Bewegung sowohl des ersten als auch des zweiten Verriegelungsteils von der ersten Position zu der zweiten Position und von der zweiten Position zu der dritten Position positioniert ist.

4. Dichtbarer, transportabler Behälter gemäß Anspruch 3, wobei das Betätigungsglied eine zweistufige Nockeneinrichtung aufweist.

5. Dichtbarer, transportabler Behälter gemäß Anspruch 1 , 2, 3 oder 4, wobei das erste und das zweite Teil für eine lineare Bewegung in der ersten Richtung und für eine schwenkbare Bewegung in der zweiten Richtung geeignet sind.

6. Dichtbarer, transportabler Behälter gemäß einem der Ansprüche 1-5, wobei die Verriegelungsteile (101_{1-2}) vollständig innerhalb der Kastentür enthalten sind, wenn sie sich in der ersten Position befinden.

7. Standardmäßiger, mechanischer Interface-(SMIF-)Behälter, der einen dichtbaren, transportablen Behälter gemäß Anspruch 1 aufweist, in dem:
der Kasten mindestens zwei Verriegelungseingriffsflächen (112) besitzt, wobei die erste und die zweite Dichtfläche eine Dichtung bilden, die den Innenbereich von den Umgebungsdruckbedingungen isoliert, wenn die Kastentür in einer Dichtrichtung hinsichtlich des Kastens bewegt wird; und
die ersten und zweiten Verriegelungsteile in der Kastentür vorgesehen sind, wobei jedes Verriegelungsteil mindestens zwei Kasteneingriffsbereiche (108) besitzt und zwischen der ersten Position, bei der es sich um eine außer Eingriff stehende Position handelt, der zweiten Position, bei der es sich um eine eingreifende Position handelt, und der dritten Position, bei der es sich um eine Eingriffsposition handelt, bewegbar ist, und die Verriegelungsteile dazu geeignet sind, sich von der außer Eingriff stehenden Position zu der Eingriffsposition ohne Berührung des Kastens zu bewegen und wobei eine Bewegung der Verriegelungsteile von der eingreifenden Position zu der in Eingriff stehenden Position bewirkt, daß sich mindestens zwei Kasteneingriffsbereiche der Verriegelungsteile entsprechende der mindestens zwei

Verriegelungseingriffsflächen ohne Kratzen der Verriegelungsteile gegen die mindestens zwei Verriegelungseingriffsflächen berühren und um die Kastentür in die Dichtrichtung bewegen, und der weiterhin aufweist:
eine zweistufige Nockeneinrichtung (103), die zentral in der Kastentür zur Bewegung der Verriegelungsteile von der außer Eingriff stehenden Position zu der eingreifenden Position in einem ersten, unabhängigen Betriebszustand und zur Bewegung der Verriegelungsteile von der eingreifenden Position zu der in Eingriff stehenden Position in einem zweiten, unabhängigen Betriebszustand angeordnet ist.

8. SMIF-Behälter gemäß Anspruch 7, wobei die Verriegelungsteile vollständig innerhalb der Kastentür in der außer Eingriff stehenden Position enthalten sind.

9. SMIF-Behälter gemäß Anspruch 7, wobei die ersten und zweiten Verriegelungsteile für eine lineare Bewegung zwischen der außer Eingriff stehenden Position und der in Eingriff stehenden Position stehenden und für eine schwenkbare Bewegung zwischen der in Eingriff stehenden Position und der eingegriffenen Position geeignet sind.

10. SMIF-System zur Aufrechterhaltung der Reinheit von Gegenständen, die behandelt werden, das aufweist:
einen SMIF-Behälter gemäß Anspruch 7, wobei der innere Bereich zur Aufnahme der Gegenstände geeignet ist, wobei der Kasten eine weitere Dichtfläche (56) besitzt;
eine Durchgangsplatte (26), die erste und zweite Durchgangsplatten-Dichtflächen (60, 62) besitzt, wobei die erste Durchgangsplatten-Dichtfläche (60) dichtend zu der weiteren Kastendichtfläche (56) paßt; und
eine Durchgangstür (28), die eine erste Durchgangstür-Dichtfläche (64) für eine dichtende Anpassung an die zweite Durchgangsplatten-Dichtfläche (62) zur Bildung einer Dichtung besitzt, wobei die Durchgangstür Einrichtungen zum Betätigen der zweistufigen Nockeneinrichtung umfaßt.

11. SMIF-System gemäß Anspruch 10, das weiterhin aufweist:
eine Kanaleinrichtung (63) zur Kommunkation zwischen einem inneren Zwischenraum und einer Umgebung außerhalb des Kastens; und
eine Filtereinrichtung (69) zur Filterung von Fluiden, die durch die Kanaleinrichtung hindurchtreten.

Revendications

1. Récipient transportable (18) scellable, comprenant :
un boîtier (20) présentant une zone intérieure (21) et une première surface d'étanchéité (54);
une porte de boîtier (32) présentant une deuxième surface d'étanchéité (58) adaptée façon à s'accoupler à ladite première surface d'étanchéité, lorsque ladite porte de boîtier est déplacée dans une direction d'étanchéité; et
des premier et deuxième organes de verrouillage (101_{1-2}) adaptés chacun a de se déplacer dans une première direction entre une première position, qui permet un déplacement de ladite porte de boîtier par rapport audit boîtier, et une deuxième position, qui limite le déplacement de ladite porte de boîtier par rapport audit boîtier, sans contact de raclage entre lesdits organes de verrouillage et ledit boîtier ou ladite porte de boîtier dans la dite zone intérieure et à se déplacer dans une deuxième direction, comprise entre ladite deuxième position et une troisième position, sans contact de raclage entre lesdits organes de verrouillage et ledit boîtier ou ladite porte de boîtier dans ladite zone intérieure, afin de déplacer ladite porte de boîtier dans la direction d'étanchéité et d'amener lesdites première et deuxième surfaces d'étanchéité en contact entre elles.

2. Récipient transportable scellable selon la revendication 1, dans lequel lesdits organes de verrouillage se situent dans ladite troisième position, ladite porte de boîtier étant supportée en des positions (105) espacées d'un bord périphérique de ladite porte de boîtier, afin d'empêcher ladite porte de boîtier de dévier.

3. Récipient transportable scellable selon la revendication 1 ou 2, comprenant en outre un organe d'actionnement (103) disposé au centre de ladite porte de boîtier, afin de déplacer à la fois lesdits premier et deuxième organes de verrouillage depuis la première position à la deuxième position et depuis la deuxième position à la troisième position.

4. Récipient transportable scellable selon la revendication 3, dans lequel ledit organe d'actionnement comprend un moyen formant came à deux étages.

5. Récipient transportable scellable selon la revendication 1, 2, 3 ou 4 dans lequel lesdits premier et deuxième organes sont adaptés de

façon à effectuer un déplacement linéaire dans la première direction et un déplacement de pivotement dans ladite deuxième direction.

6. Récipient transportable scellable selon l'un quelconque des revendications 1 à 5, dans lequel lesdits organes de verrouillage (101_{1-2}) sont entièrement contenus dans ladite porte de boîtier, lorsqu'elle se situe dans ladite première position.

7. Nacelle d'interface mécanique standard (SMIF) comprenant un récipient transportable scellable selon la revendication 1, dans lequel :

ledit boîtier présente au moins deux surfaces de contact de verrouillage (112), lesdites première et deuxième surfaces d'étanchéité forment un joint d'étanchéité qui isole ladite zone intérieure par rapport à des conditions de pression ambiante, lorsque ladite porte de boîtier est déplacée dans une direction d'étanchéité par rapport audit boîtier; et

lesdits premier et deuxième organes de verrouillage sont prévus dans ladite porte de boîtier, chaque organe de verrouillage présentant au moins deux parties de contact de boîtier (108) et pouvant se déplacer entre ladite première position, qui est une position désengagée, ladite deuxième position qui est une position d'engagement et ladite troisième position qui est une position engagée, et lesdits organes de verrouillage sont adaptés de façon à se déplacer depuis la position désengagée à la position d'engagement, sans entrer en contact avec ledit boîtier et de manière que le déplacement desdits organes de verrouillage depuis la position d'engagement à la position engagée force lesdites au moins deux parties d'engagement de boîtier desdits organe de verrouillage à venir au contact des surfaces respectives parmi lesdites au moins deux surfaces d'engagement de verrouillage, sans racler lesdits organes de verrouillage contre lesdites au moins deux surfaces d'engagement de verrouillage et à déplacer ladite porte de boîtier dans la direction d'étanchéité; et comprenant en outre :

un moyen formant came à deux étages (103) disposé au centre dans ladite porte de boîtier, afin de déplacer lesdits organes de verrouillage depuis la position désengagée à la position d'engagement, lors d'une première étape indépendante de fonctionnement et de déplacer lesdits organes de verrouillage depuis la position d'engagement à la position engagée, lors d'une deuxième étape indépendante de fonctionnement.

8. Nacelle (SMIF) selon la revendication 7, dans laquelle lesdits organes de verrouillage sont entièrement contenus dans ladite porte de boîtier, dans ladite position désengagée.

9. Nacelle (SMIF) selon la revendication 7, dans laquelle lesdits premier et deuxième organes de verrouillage sont adaptés de façon à effectuer un mouvement linéaire entre la position désengagée et la position d'engagement et un déplacement de pivotement entre la position d'engagement et la position engagée.

10. Système (SMIF) servant à maintenir la propreté des articles à traiter comprenant :

une nacelle (SMIF) selon la revendication 7, la zone intérieure étant adaptée de façon à contenir les articles, le boîtier présentant une autre surface d'étanchéité (56);

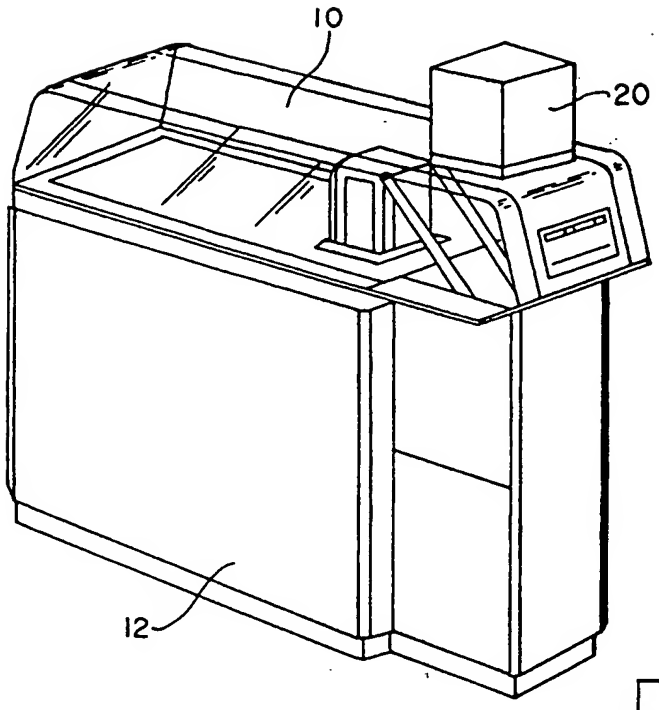
une plaque à ouverture (26) présentant des première et deuxième surfaces d'étanchéité de plaque à ouverture (60; 62), ladite première surface d'étanchéité de plaque à ouverture (60) s'accouplant de façon étanche avec l'autre surface d'étanchéité de boîtier (56); et

une porte d'ouverture (28) présentant une première surface d'étanchéité de porte d'ouverture (64), destinée à s'accoupler de façon étanche avec la deuxième surface d'étanchéité de plaque à ouverture (62), afin de former un joint d'étanchéité, la porte d'ouverture comprenant un moyen servant à actionner ledit moyen formant came à deux étages.

11. Système (SMIF) selon la revendication 10, comprenant en outre :

un moyen formant conduit (63) servant à établir une communication entre l'espace intérieur et un environnement extérieur au boîtier; et

un moyen de filtrage (69) servant à filtrer des fluides passant dans le moyen formant piste.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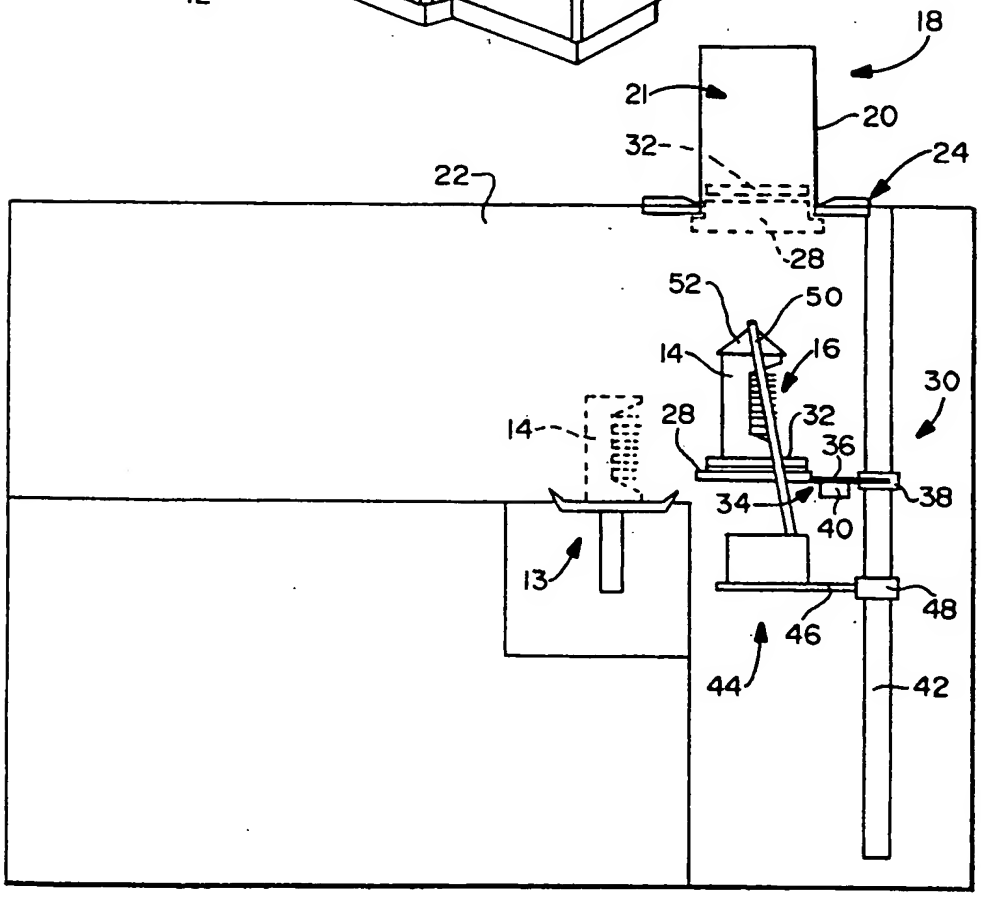
12

FIG.-1A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44
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FIG.-1B

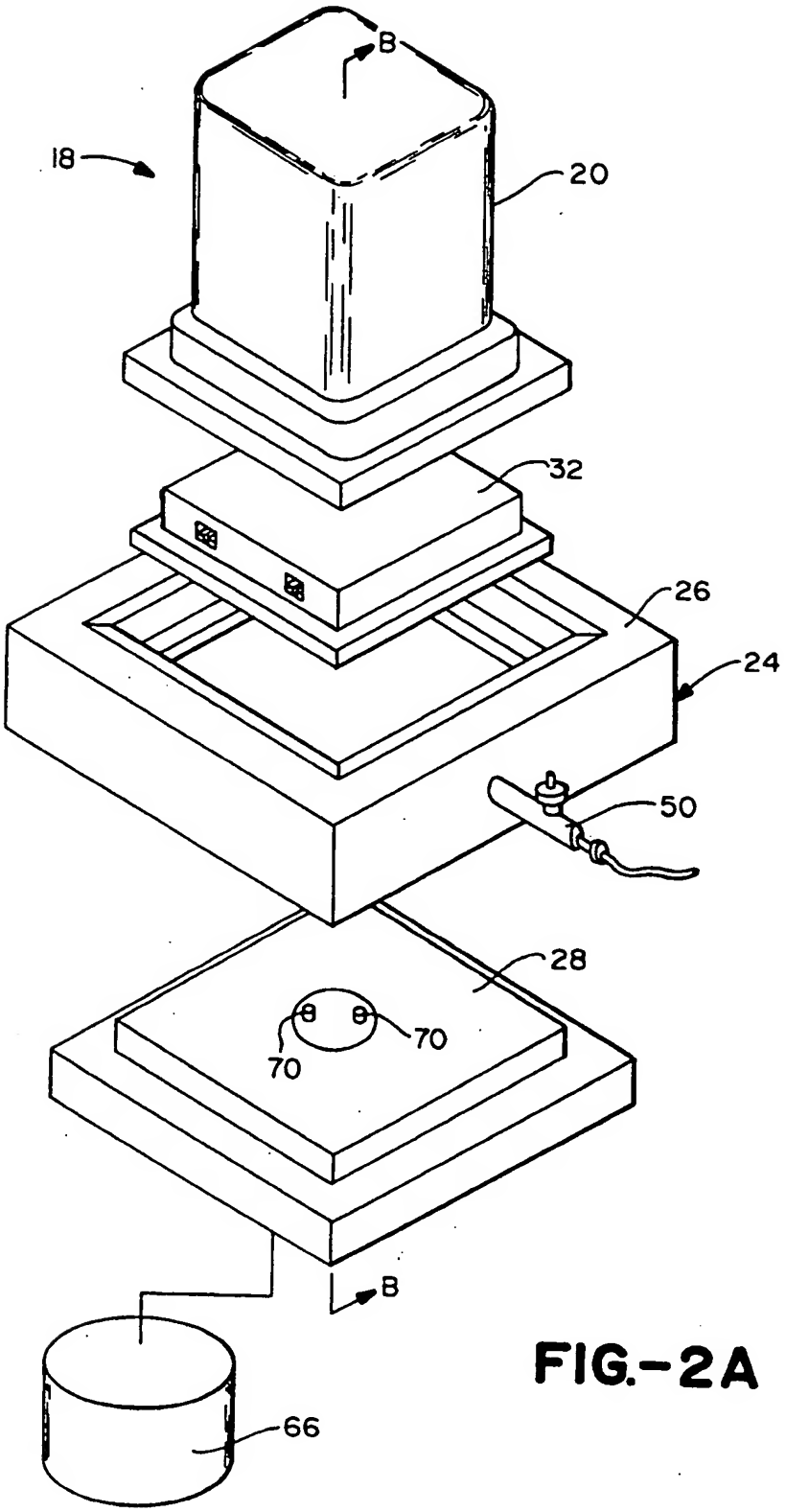


FIG.-2A

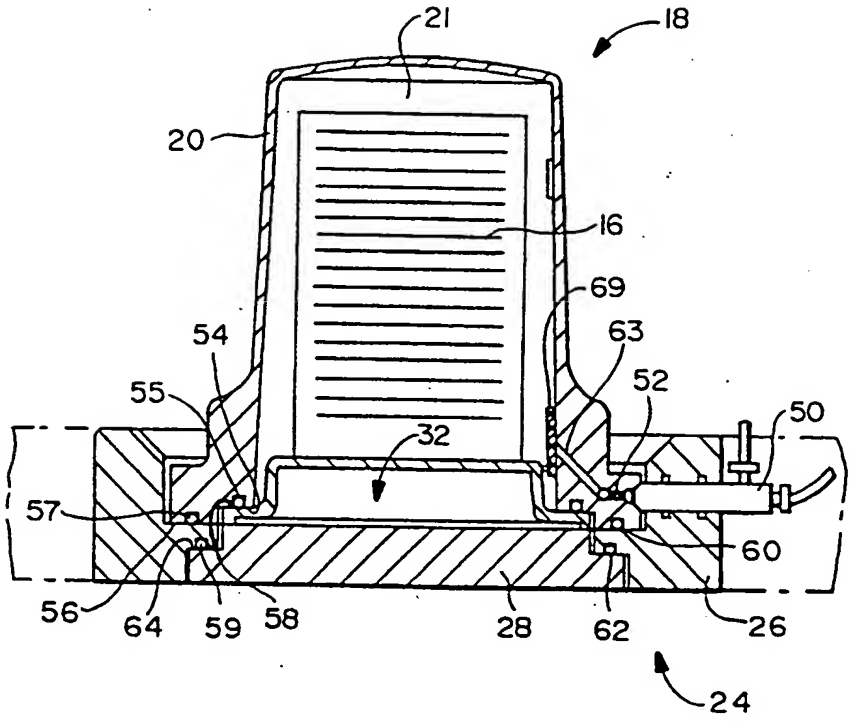


FIG.-2B

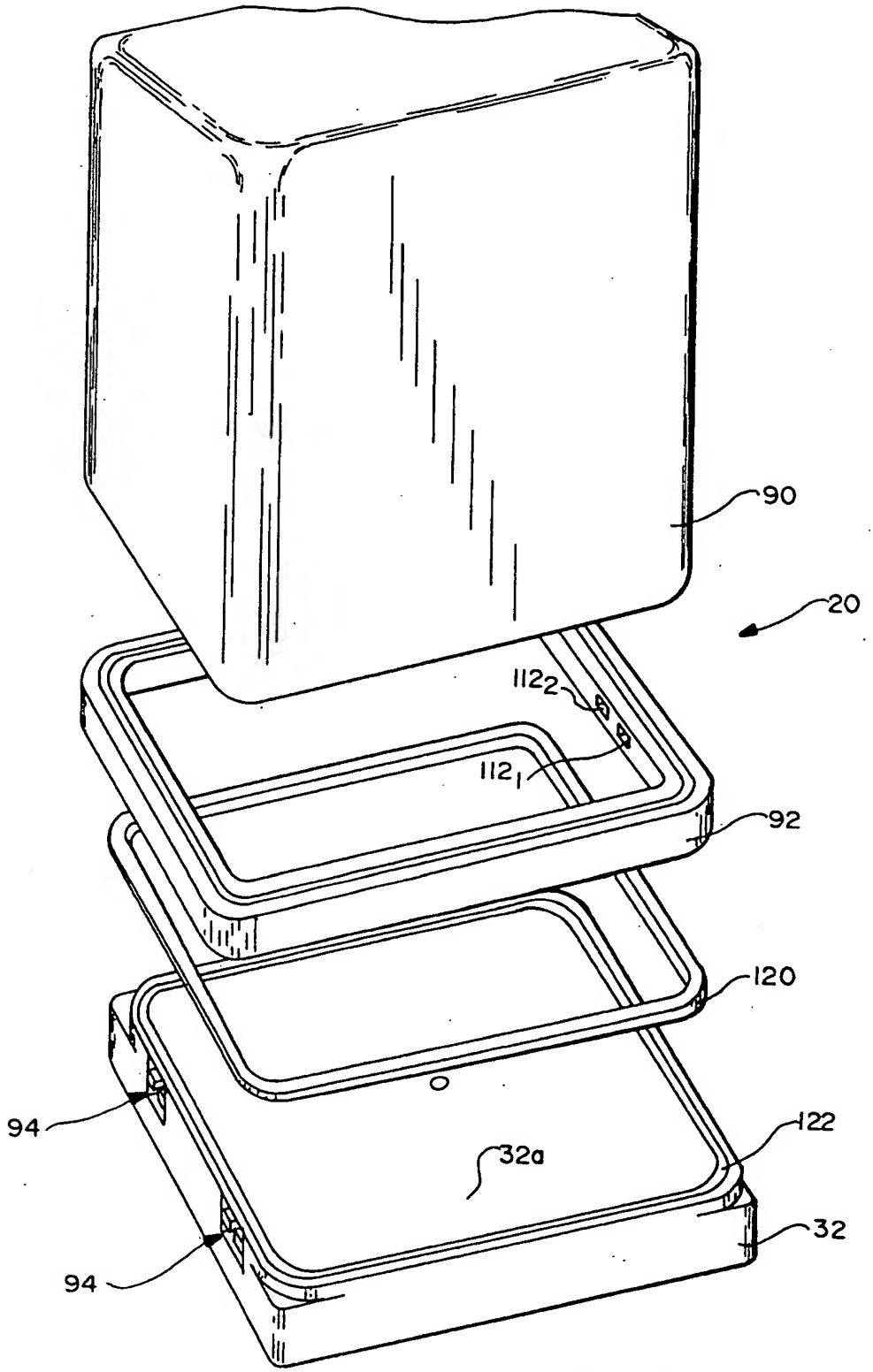
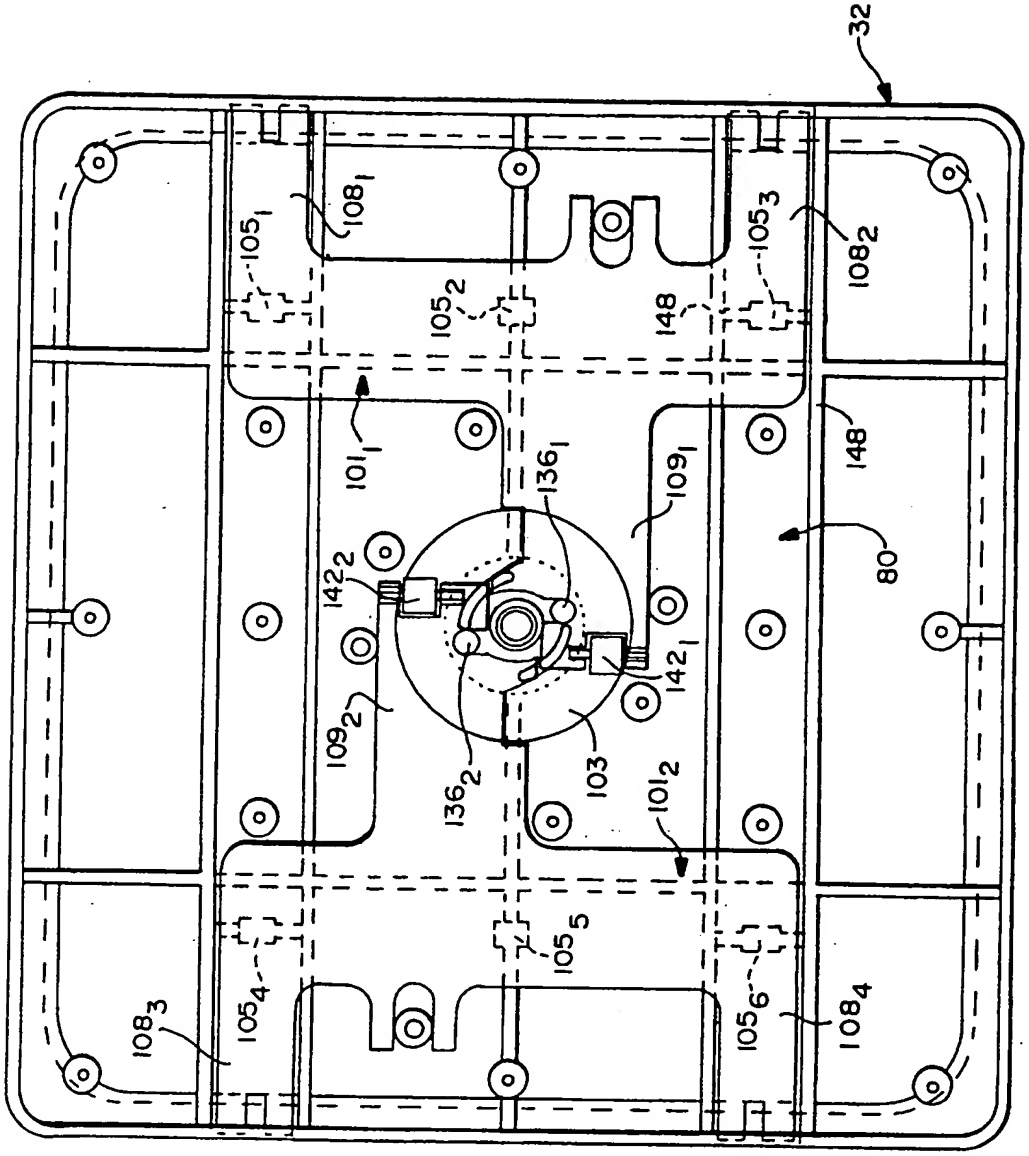


FIG.-3

FIG.-4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108_1
105_1
105_2
148
105_3
108_2
101_1
136_1
109_1
148
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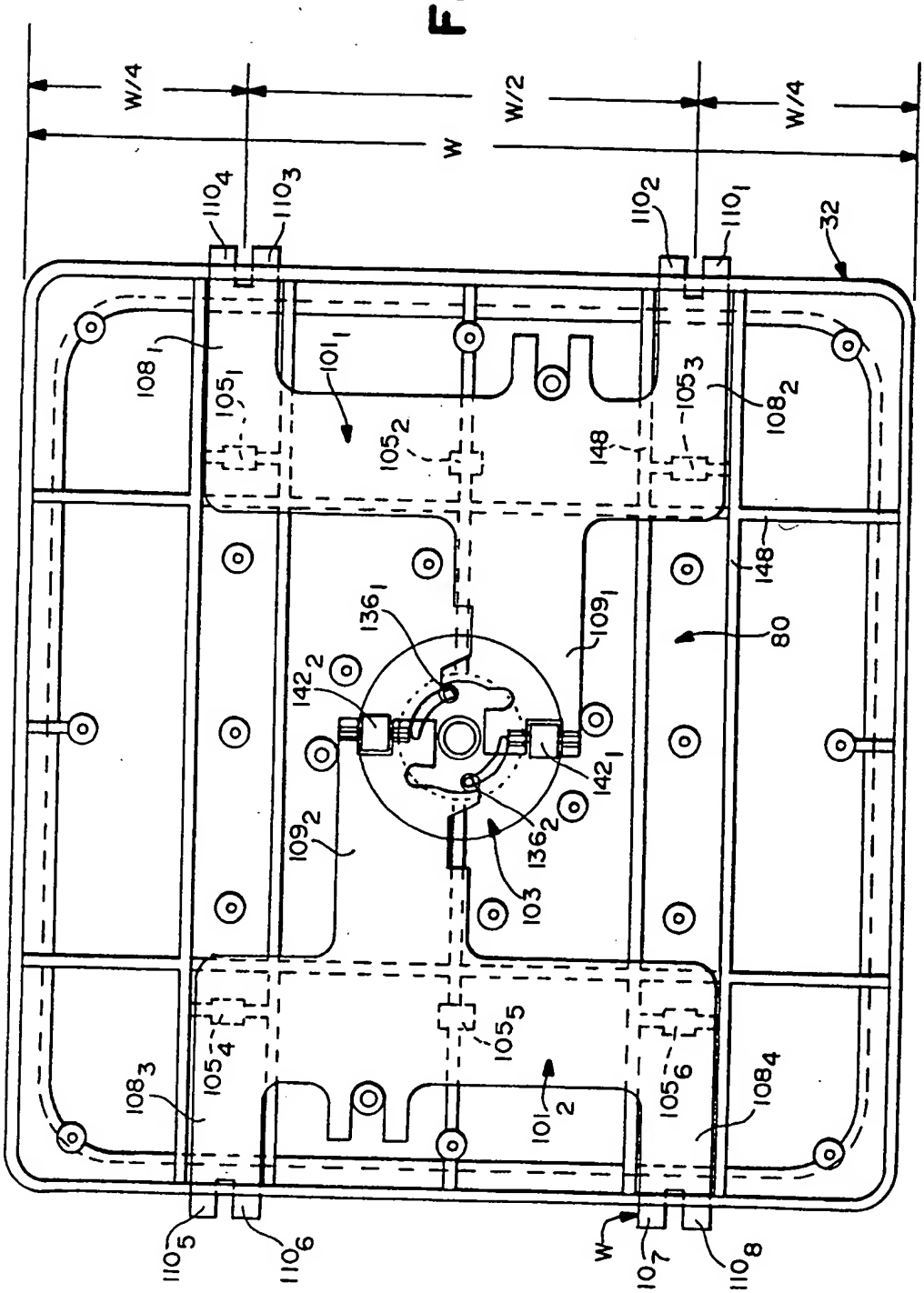
109_2
136_2
103
101_2
105_5
105_4
108_3
105_6
108_4

FIG.-5


W/4
W/2
W/4
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110_4
110_3
110_2
110_1
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108_1
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105_3
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148
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109_1
80
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109_2
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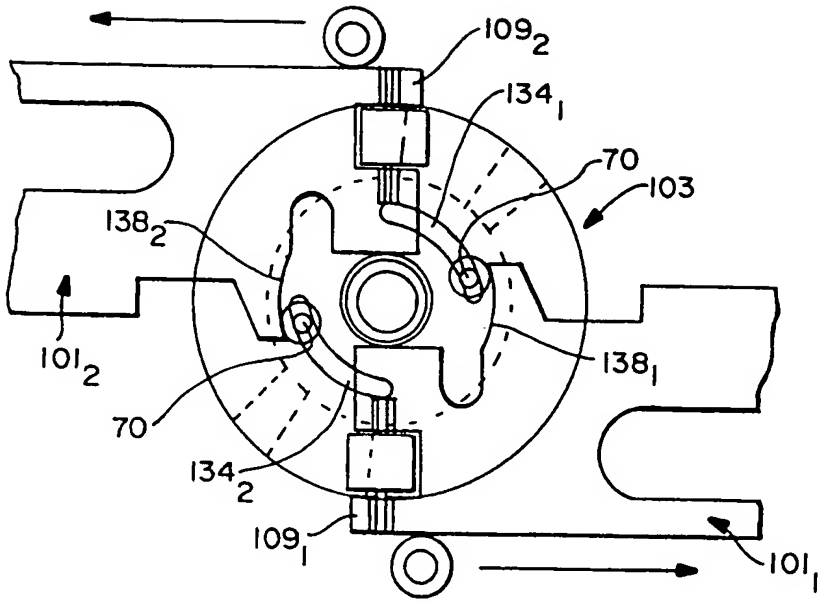
110_8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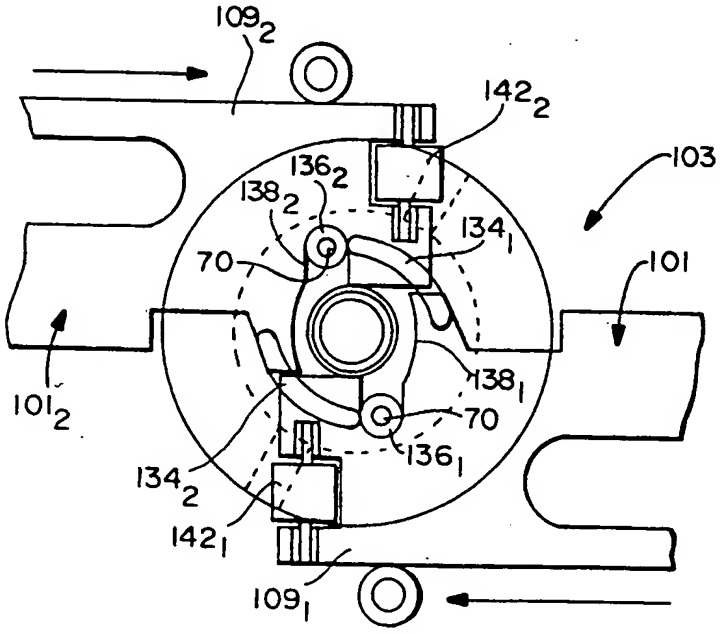
70
103
138_2
101_2
138_1
70
134_2
109_1
101_1

FIG.-6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142_2
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101_2
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70
136_1
134_2
142_1
109_1

FIG.-7

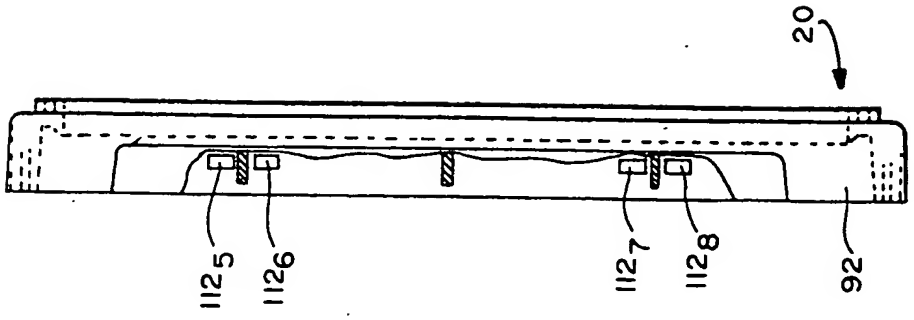

20
112 5
112 6
112 7
112 8
92

FIG.-9

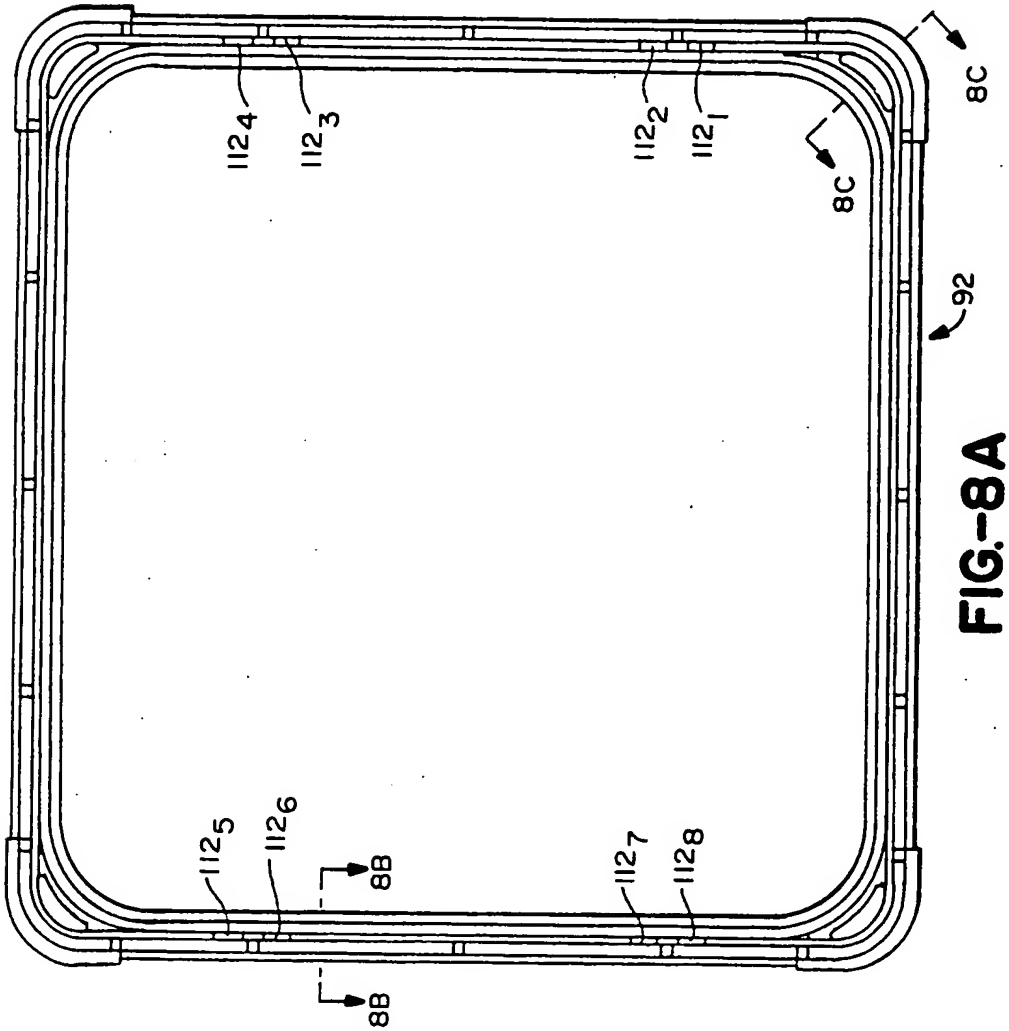

112 4
112 3
112 2
112 1
8C
8C
92
112 5
112 6
8B
112 7
112 8
8B

FIG.-8A

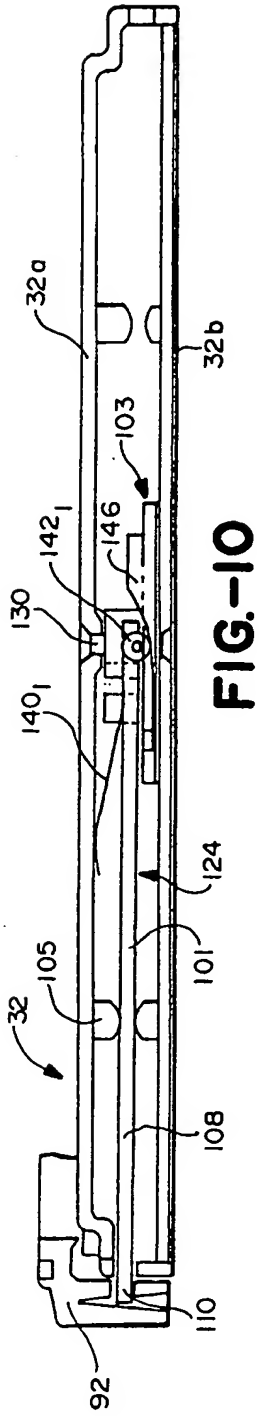


FIG.-10

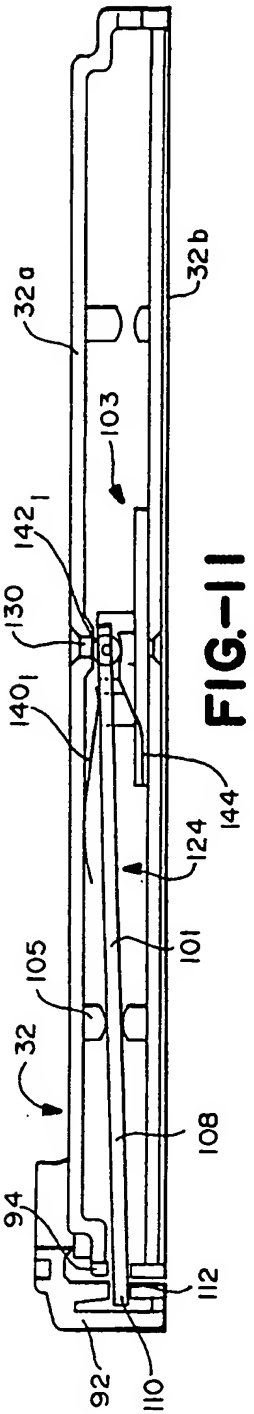


FIG.-11

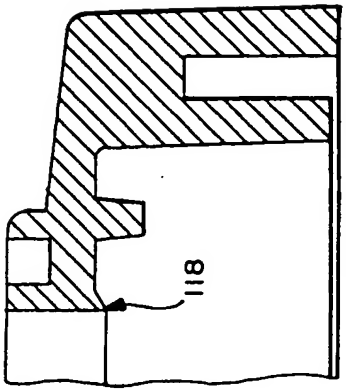


FIG.-8C

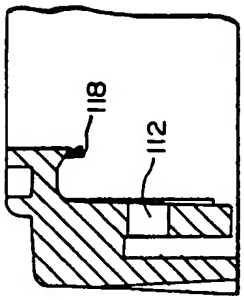


FIG.-8B

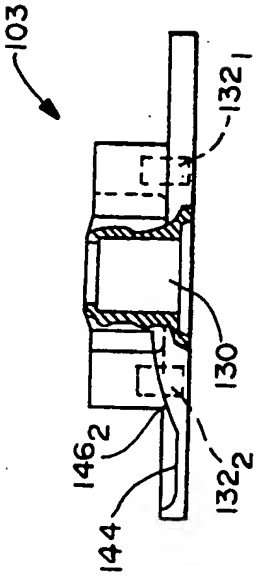
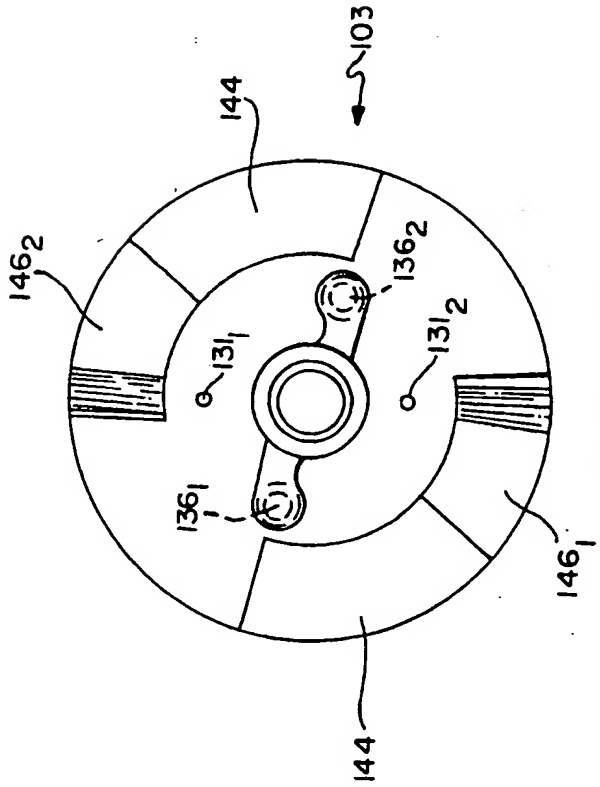

103
132_1
130
146_2
132_2
144

FIG.-13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146_2
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131_2
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136_1
146_1
144

FIG.-12

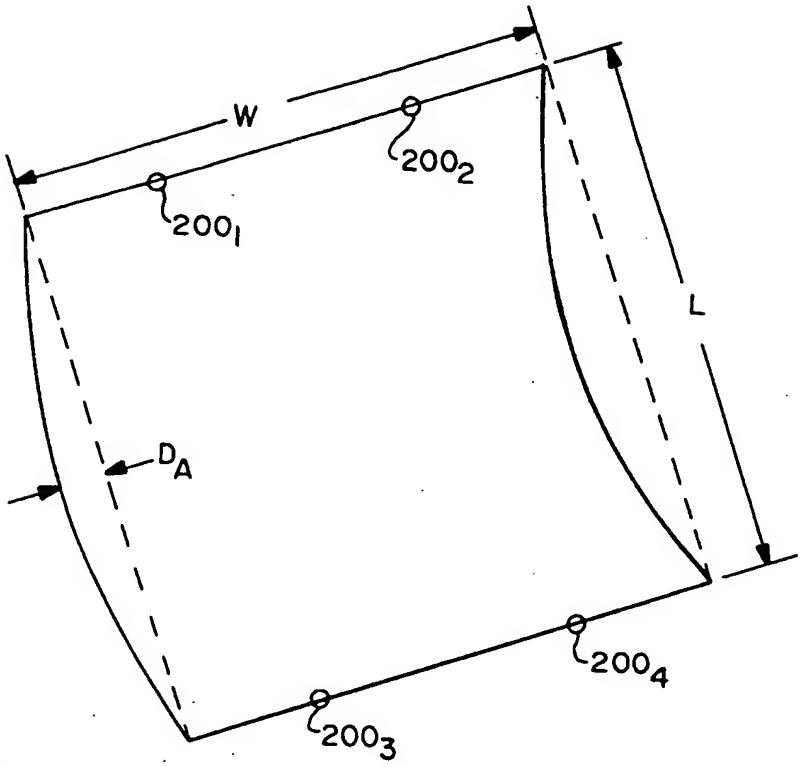

FIG.-14A

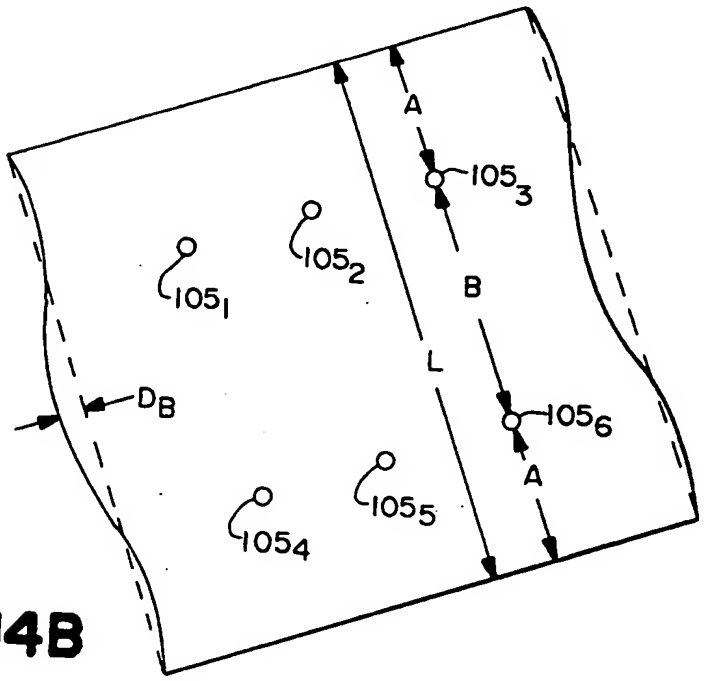

FIG.-14B

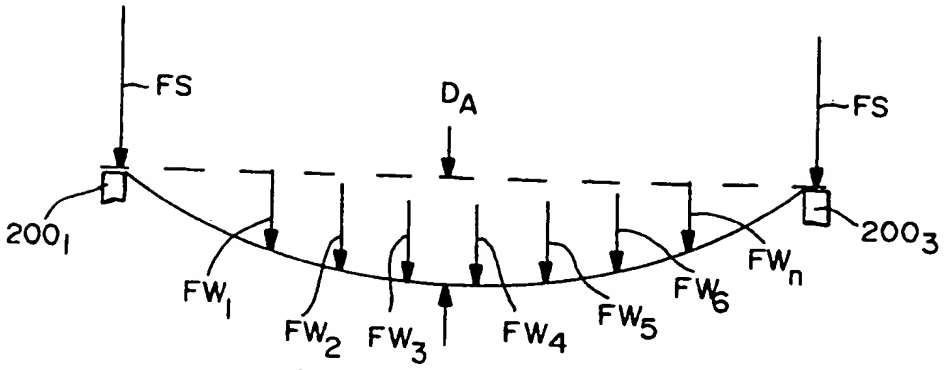

FIG.-15A

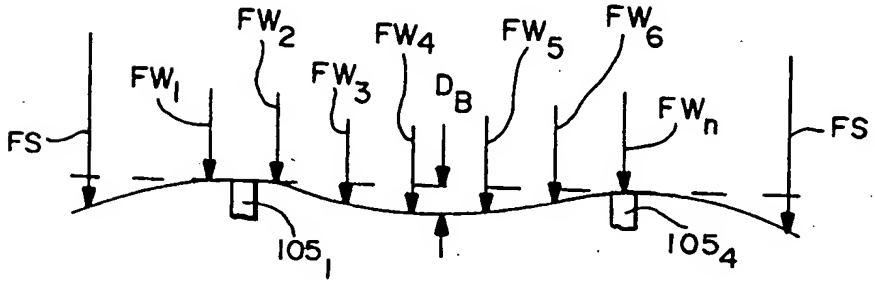

FIG.-15B